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Concept for CBRN Air-Purifying Escape Respirator Standard

(1) Goal:

Develop a NIOSH standard for escape only air-purifying respirators that addresses CBRN materials identified as inhalation hazards from possible terrorist events for use by the general working population.

(2) Hazard Categories:

Defining appropriate hazard levels for escape from a possible chemical, biological, radiological and nuclear (CBRN) terrorist event is a complex problem. Analysis of possible escape scenarios indicates the range of possible hazard concentrations at and between levels typically identified by emergency responders as the Hot Zone and the Warm Zone. The Hot Zone is ground zero and can be characterized as the hazard levels associated with a likely terrorist event, "Most Credible Event" (MCE). MCE's for chemical warfare agents (CWA's) and toxic industrial materials (TIM's) expected at a terrorist event are determined using a modeling process (US ARMY). The MCE model considers several parameters associated with the potential event. These parameters include the means used to transport the CWA or TIM to the scene, the method of dissemination of the hazard, properties of the hazard, the quantity of the CWA or TIM used, the availability of the CWA or TIM, and physical characteristics of the area such as room size and the degree of ventilation present. Using this approach MCE's for sarin gas, GB, and sulfur mustard, HD were determined to be 2000 mg/m³ for GB and 300 mg/m³ for HD. Similar modeling techniques are currently being employed for TIM's that have also been identified as high threat possibilities.

Warm Zone analysis of the CWA's and TIM's are determined by the immediately dangerous to life or health, IDLH, concentrations or equivalent for the identified hazards. For GB and HD the equivalent warm zone concentrations can be set at 0.19 mg/m³ GB and 2.7 mg/m³ HD, based on Acute Exposure Guideline Levels (AEGL's), AEGL 2 values at 30 minutes.

Based on the Hot Zone / Warm Zone GB and HD concentrations it can be expected that respirator performance requirements for escape from the Hot Zone are different from those requirements for escape from or near Warm Zone concentrations. In addition, the characteristics of the diverse hazards and buildings or site characteristics vary significantly. No two are expected to be identical. Because of this a wide range of escape strategies is expected. Certain conditions may involve a dual response strategy: use of an escape respirator and/or shelter in place. Escape only air-purifying respirators designed for specific hazards at levels between the Hot and Warm Zones may be appropriate for specific escape scenarios but do not represent a universal escape respirator solution for protecting all or the majority of workers. Furthermore, requirements for acceptable escape respirator performance for a skyscraper are most likely different than acceptable escape respirator performance from a 3-level building. The threat for a metropolitan area located near a major industrial complex, a chemical plant or oil refinery is not

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the same as the threat for metropolitan areas removed from industry.

The concept for escape respirator performance requirements to address the wide range of variables is segmented into three categories: **HIGH**, **SPECIFIC**, and **LOW**. The categories are associated with a level of protection as follows:

HIGH: Self-Contained Escape Respirator for unknown conditions and oxygen deficiency.

SPECIFIC: Air Purifying Escape Respirator for high concentrations of CWAs and specific TIMs.

LOW: Air Purifying Escape Respirator for low concentrations of CWAs and TIMs.

The standard discussed in this concept paper addresses the **SPECIFIC** and **LOW** categories for air purifying escape respirators. The **HIGH** category, self-contained escape respirator, is part of the standards development program scheduled for 2004.

2(a) Category vs. Hazard vs. Escape Respirator Type:

Table 1. Escape Respirator Categories

| Category | Hazard Description | Respirator Type |
|---------------------------------------|--|---|
| HIGH (Hot & Warm Zones) | CWA & TIM Hazard Threats at High Concentrations and/or Oxygen Deficiency | Self Contained Escape Respirator |
| SPECIFIC (Hot & Warm Zones) | CWA + Specific TIM Hazard Threats at High Concentrations | Specific Gas/Vapor + CWA Air Purifying Escape Respirator |
| LOW (Warm Zone) | CWA & Multiple Hazard Threats at Low Concentrations | Multi Gas/Vapor/Particulate Air Purifying Escape Respirator |

2(b) Escape Respirator Multi Gas/Vapor/Particulate Requirements LOW Category:

Multi Gas/Vapor/Particulate Escape respirators for use at low hazard threat conditions shall meet the gas/vapor test challenge concentrations as follows:

| | Test Concentration (ppm) Draft | Breakthrough Concentration (ppm) Draft |
|-------------------|-----------------------------------|---|
| Ammonia | 2500 | 12.5 |
| Cyanogen Chloride | 300 | 2 |
| Cyclohexane | 3900 | 10 |
| Formaldehyde | 1000 | 1 |
| Hydrogen Cyanide | 940 | 4.7 |
| Hydrogen Sulfide | 1000 | 5.0 |
| Nitrogen Dioxide | 200 | 1 |
| Phosgene | 250 | 1.25 |
| Phosphine | 300 | 0.3 |
| Sulfur Dioxide | 1500 | 5 |

2(c) Escape Respirator Multi Gas/Vapor/Particulate LOW Category with Carbon Monoxide Requirements:

Escape respirators intended for use at low hazard threat conditions with carbon monoxide protection shall meet the requirements of paragraph 2(b) plus carbon monoxide as follows:
To Be Determined, TBD

2(d) Escape Respirator Specific Gas/Vapor/Particulate Plus CWA Requirements SPECIFIC Category:

Escape respirators intended for use at high hazard threat conditions shall meet the gas/vapor/particulate testing at MCE concentrations. Minimum test agents are as follows:

| | Test Concentration (ppm) Draft | Breakthrough Concentration (ppm) Draft |
|-------------------|-----------------------------------|---|
| Cyclohexane | TBD | TBD |
| Sulfur Dioxide | TBD | TBD |
| Cyanogen Chloride | TBD | TBD |
| Hydrogen Cyanide | TBD | TBD |
| Hydrogen Sulfide | TBD | TBD |

Additional specific test agent protections can be added to the minimum as specified by the applicant for: Ammonia, Formaldehyde, Nitrogen Dioxide, Phosgene, Phosphine and Carbon Monoxide. Test concentrations are at MCE concentrations, TBD.

(3) Respirator Use:

- 3(a) Escape respirators are intended to be one time use for escape from terrorist events.
- 3(b) Panic Demand: Escape respirators will be tested at a high physiologic demand, 100 liter per minute for the rated service life of the device.
- 3(c) Escape respirators will be rated for 15 minute or 30 minute service life.

(4) Gas Life Test Requirements:

- 4(a) Test Duration: Test duration will be 15 or 30 minutes as specified by the applicant.
- 4(b) Particulate Filtration: P100 required.

(5) Environmental Conditioning: Environmental conditioning will be performed. Detailed requirements TBD.

- 5(a) Environmental Conditioning : Hot Storage, Cold storage, Humidity, Vibration and Drop
- 5(b) Service life testing will be done on environmentally conditioned respirators.

(6) Performance Requirements: Escape respirator performance requirements considered will include the following with details TBD:

- 6(a) System Agent Penetration / Permeation Testing for escape respirators intended for escape shall be tested for live agent performance as follows: TBD
- 6(b) Breathing Resistance: TBD
- 6(c) Carbon Dioxide: TBD
- 6(d) Communications (Speech Intelligibility): TBD
- 6(e) Field of View: TBD
- 6(f) Donning: TBD
- 6(g) Fogging: TBD
- 6(h) Heat Exposure: TBD.
- 6(i) Flamability of Materials: TBD.
- 6(j) Laboratory Respirator Protection Level: TBD.

(7) Design Considerations: The following design features will be considered:

- 7(a) Hood Type Device: TBD.
- 7(b) Dermal protection required for escape respirators intended for Hot Zone Hazard levels.
- 7(c) Weight: TBD

(8) 42 CFR Applicable Sections: TBD.

(9) Service and Maintenance: TBD

(10) Training: TBD

